THE EFFECTS OF FLUAZIFOP-P-BUTYL AND CUTTING TREATMENTS ON THE ESTABLISHMENT OF SOWN FIELD MARGIN STRIPS

E. J. P. MARSHALL

Department of Agricultural Sciences, University of Bristol, Institute of Arable Crops Research, Long Ashton Research Station, Bristol BS18 9AF, UK

M. NOWAKOWSKI

Willmot Pertwee Conservation, West Yoke, Ash, Nr. Wrotham, Kent TN15 7HU, UK

ABSTRACT

A field experiment compared the effects of a graminicide, with and without mowing, on sown grass and wildflower strips at the edge of an arable field. Strips were sown in September 1991, treated with fluazifop-P-butyl ("Fusilade 5") in December and either left uncut or mown up to four times during the following spring and summer. The seed mixture contained a proportion of annuals which dominated the plots, especially in the first year after establishment. The graminicide did not adversely affect *Festuca* species, but reduced frequencies of other sown grasses. Two or more cuts in 1992 reduced the cover of annual species and as a result, plots were more diverse in 1992 and had the most sown dicotyledonous species in the following year. Where the annuals dominated and subsequently lodged, they were able to persist through the second year and plant diversity was reduced.

INTRODUCTION

Field margins constitute a network of semi-natural habitat in farm landscapes which interact with adjacent agriculture. Such semi-natural areas have a number of potential roles in more sustainable farming systems (Marshall, 1993). Expansion of the perennial ground flora at arable field edges has potential for increasing on-farm biodiversity, for controlling annual weed species of hedgerows that may colonise adjacent crops (Marshall, 1989) and for enhancing populations of beneficial insects (Thomas *et al.*, 1992). Previous work on the introduction of sown grass and wildflower strips has demonstrated that in fertile arable soils, suitable control of weed grasses in the first year is required. The herbicide fluazifop-P-butyl, will control many such grasses while leaving *Festuca* species unaffected (Marshall & Nowakowski, 1992). However, there were indications that sown grasses could also be adversely affected, while repeated cutting could reduce the frequencies of annual species. Confirmation of these results was sought in an experiment using the graminicide fluazifop-P-butyl and a variety of cutting treatments in the first year after sowing. In addition, natural regeneration (set-aside) and plots sown only with grasses were established.

METHODS

A replicated experiment with eleven plot treatments was established in September 1991 along a field margin bounded by a farm track. The experiment was located on Radcot Bridge

Farm, Oxfordshire (NGR: SU 275995). Each plot was 3 m wide and 8 m long; treatments were located at random along the margin within three replicate blocks. Treatment details are summarised in Table 1. Plots were either allowed to regenerate naturally from the soil seed bank or sown on 9 September 1991 with a grass-only mixture or a grass and wildflower mixture. The grass seed mixture contained 12 species and varieties and was sown at a rate equivalent to 37 kg/ha. The grass/herb mixture contained the same grasses, plus six annual and 23 perennial dicotyledonous species sown at the same rate. Herbicide was applied using an AZO sprayer fitted with a 3 m boom and flat fan jets delivering medium spray quality at 250 l/ha at 3 bars pressure. Mowing treatments were made with a pedestrian rotary mower cutting to between 3 and 5 cm, followed by raking off the cut vegetation. All plots were mown on 4 September 1992 and 21 April 1993.

In 1992, percentage cover of sown annual species was estimated for each species by two independent observers in early July, before the July mowing treatment. Between 17 and 22 July 1992, live vegetative presence/absence of species was assessed in six 0.1 m^2 quadrats in each of the 33 plots. Each species was given a score out of six dependent on the number of quadrats where it was recorded. Differences between treatments were tested using analysis of variance, with differences between means assessed using Least Significant Differences (LSD; P=0.05). Where necessary, data were transformed using a logarithm transformation ($\log_e$ N+0.5). Data for species groups (sown and unsown grasses, annual and perennial dicotyledons) and for all species were analysed as the sum of 0-6 scores divided by six to be expressed as numbers of species per quadrat. The presence/absence data were collected again on 8 July 1993, towards the end of the second season after sowing.

TABLE 1. Field edge plot treatments after sowing on 9 September 1991.

Code	Sowing	Herbicide and cutting treatment
Setaside	Natural regeneration	
Grass	Grasses only	; isoxaben at 125 g AI/ha on 17 September 1991
Untreated	Sown mixture	; Untreated
X	"	; fluazifop-P-butyl at 94 g AI/ha on 2 December 1991; Uncut
XA	"	; " Cut in April
XAM	"	; " Cut in April, May
XAMJ	"	; " Cut in April, May, June
XAMJJ	"	; " Cut in April, May, June, July
XAMJul	"	; " Cut in April, May, July
XAJJ	"	; " Cut in April, June, July

Mowing dates were: 18 April, 19 May, 22 June and 27 July 1992

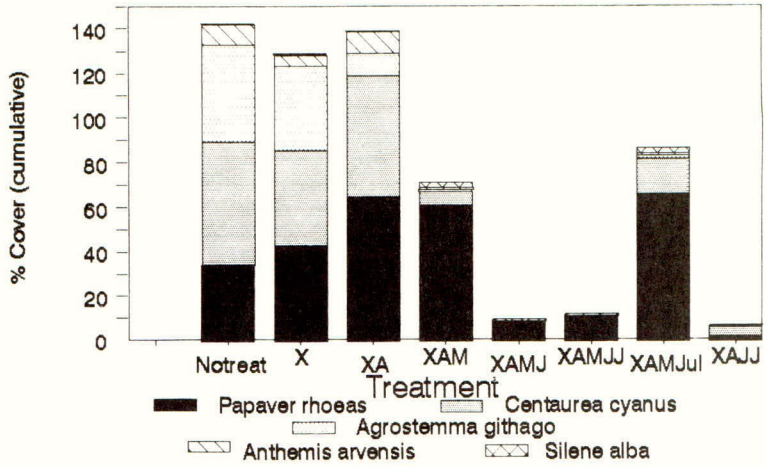
RESULTS

Cover of sown annuals in July 1992

Sown annual species dominated ground cover in the first year in plots which were unmown or cut only once (Figure 1). Fluazifop-P-butyl alone had no significant (P=0.05) influences on the cover of sown annuals compared with the untreated control. However,

mowing in June significantly reduced the cover of the dominant sown annuals *Papaver rhoeas*, *Centaurea cyanus*, *Agrostemma githago* and *Anthemis arvensis* in early July. A single cut in April, following fluazifop-P-butyl in December, also reduced cover of *A. githago* compared with controls. Mowing in April and May promoted cover of *P. rhoeas* and *S. alba* but reduced cover of *C. cyanus*, *A. githago* and *A. arvensis*.

Figure 1. Cumulative percentage ground cover of sown annual species (the sum of individual species cover) in field margin strips, some treated with fluazifop-P-butyl (X) and mown in April (A), May (M), June (J) or July (J;Jul).



Species diversity in July 1992 and 1993

In 1992, total species diversity, measured as the mean number of species found per quadrat was least on set-aside, grass-only, fluazifop-P-butyl and fluazifop-P-butyl+April cut plots (Table 2).

TABLE 2. Mean number of plant species found per quadrat on plots at the edge of an arable field sown with different seed mixtures and treated in various ways (see Table 1 for treatment code details). SED = standard error of the difference between means (df=18).

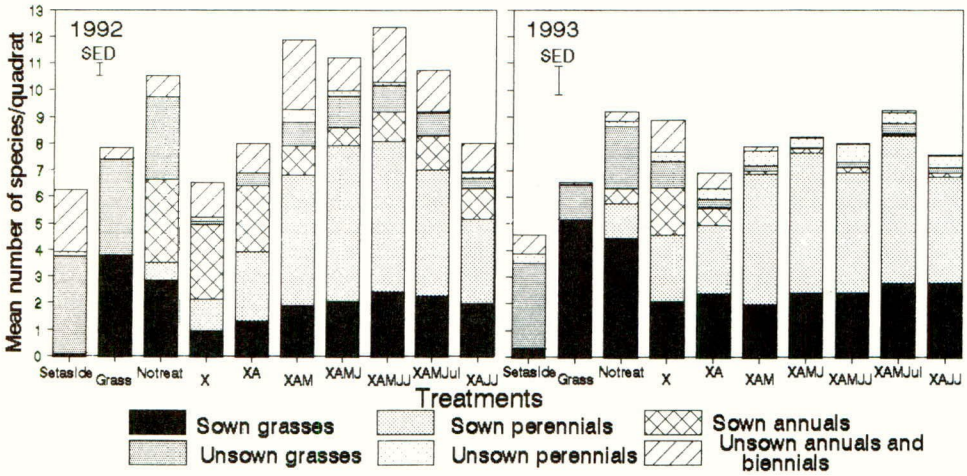
Treatment code:	Set-aside	Grass	Un-treated	X	XA	XAM	XAMJ	XAMJJ	XA MJul	XAJJ	SED
1992	6.80	7.88	10.62	6.62	8.22	12.78	12.45	13.67	11.95	8.72	0.483
1993	5.95	7.17	9.45	9.33	7.05	8.22	8.33	8.05	9.28	7.67	1.112

Highest mean species number was recorded on plots treated with fluazifop-P-butyl and subsequently mown four times. However, these plots did not have significantly more species than plots mown only in April and May. Application of fluazifop-P-butyl reduced diversity compared with sown, untreated plots. Repeated mowing reversed this effect. The results from 1993 indicate an overall reduction in diversity with time, with the exception of fluazifop-P-butyl-only plots. Compared with the untreated control plots, there were no differences among cutting + fluazifop-P-butyl treatments, with the exception of the April only cutting

In 1993, these plots were just significantly less diverse than the control plots. A feature of the 1993 data was the increased variability, as shown by the SED value, despite the overall decline in diversity.

Examination of the six main groupings of the flora, sown and unsown grasses, perennial and annual (and biennial) dicotyledonous species, illustrated varying effects of the treatments (Figure 2). In 1992 and 1993, sown grasses were most frequent on grass-only and untreated plots and least diverse on fluazifop-P-butyl-only and set-aside plots. Mowing in April and May encouraged sown grasses. Weed grasses were well controlled by fluazifop-P-butyl, their diversity remaining less than on set-aside, grass-only and untreated but sown plots. Sown perennials were less diverse on fluazifop-P-butyl-only plots than on any which then received a cut. Two or more cuts significantly increased sown perennials. In contrast, the diversity of sown annuals was reduced by more than one cut. Differences in grass diversity between cutting treatments in 1992, were no longer significant in 1993. Nevertheless, a significant increase in diversity of perennial dicotyledonous species was maintained in both years with the application of two or more mowings, compared with no treatment or fluazifop-P-butyl alone. Sown annuals had highest frequencies on the latter-treated plots, remaining significantly reduced on plots that had at least two cuts.

Figure 2. Mean numbers of species per quadrat in 1992 and 1993 in field margins strips allowed to regenerate (Setaside), sown with grasses only (Grass), or grasses and wild flowers and treated with fluazifop-P-butyl and mown in April (A), May (M), June (J) or July (J,Jul). (SED bar is for total number of species per quadrat)



Individual species

The effects of treatments on selected species are shown in Table 3. The sown grass, *Festuca rubra*, was encouraged by the application of fluazifop-P-butyl. In contrast, *Trisetum flavescens* was reduced in frequency and *A. myosuroides* was largely controlled by the graminicide. The latter retained high frequencies on set-aside plots, but was reduced on sown grass-only and untreated plots in 1993. *Galium aparine*, a winter-germinating annual, was reduced in frequency in 1992 by two cuts. In 1993, the data were not significantly different

between treatments, though the species had similar frequencies on fluazifop-P-butyl plots in both years. Sown *A. githago* was severely affected by cutting in 1992 and was absent in 1993 from those plots which had been mown at least twice. The sown perennial, *L. vulgare*, was encouraged in both years by mowing, with some increase in frequency on plots treated with the graminicide.

TABLE 3. Transformed mean frequency scores ($\log_e$+0.5) of selected plant species on field edge plots in the two seasons after sowing.

Treatment code:	Set-aside	Grass	Un-treated	X	XA	XAM	XAMJ	XAMJJ	XA MJul	XAJJ	SED
Festuca rubra - sown grass											
1992	-0.69	1.75	1.31	1.57	1.54	1.87	1.87	1.87	1.87	1.87	0.134
1993	-0.69	1.87	1.61	1.87	1.87	1.76	1.87	1.87	1.82	1.87	0.091
Trisetum flavescens - sown grass											
1992	-0.69	1.82	1.75	0.21	1.29	1.34	1.61	1.71	1.69	1.64	0.256
1993	-0.05	1.87	1.87	1.42	1.57	1.31	1.50	0.86	1.34	1.57	0.334
Alopecurus myosuroides - annual weed grass											
1992	1.87	1.87	1.55	-0.69	-0.69	-0.69	-0.33	-0.69	-0.69	-0.69	0.211
1993	1.82	0.49	1.12	0.58	0.21	-0.69	-0.69	-0.33	-0.69	-0.69	0.355
Leucanthemum vulgare - sown perennial dicotyledon											
1992	-0.69	-0.69	-0.33	-0.33	-0.16	1.71	1.71	1.71	1.54	1.21	0.374
1993	-0.69	-0.69	0.32	0.49	1.31	1.14	1.64	1.75	1.64	1.69	0.394
Agrostemma githago - sown annual											
1992	-0.69	-0.69	1.67	1.69	0.77	0.04	-0.33	-0.69	-0.69	0.69	0.339
1993	-0.69	-0.69	0.38	1.22	0.32	-0.69	-0.69	-0.69	-0.69	-0.69	0.365
Galium aparine - annual dicotyledonous weed											
1992	1.69	1.05	1.05	1.01	0.58	-0.69	-0.33	-0.33	-0.69	-0.69	0.418
1993	0.69	-0.33	0.04	1.01	0.53	-0.69	-0.69	-0.69	-0.69	-0.69	0.595

DISCUSSION

The sown annual species, *P. rhoeas*, *C. cyanus*, *A. githago* and *A. arvensis*, were highly competitive, especially in the year after sowing. Where only one cut in April or no cutting was applied, species diversity in 1992 was reduced, compared with two or more cutting treatments. This reflected poorer establishment of the sown grasses and perennial dicotyledonous species under cover of the annuals. In addition, the December application of fluazifop-P-butyl resulted in reduced frequencies of sown *T. flavescens*, *P. pratense* and *C. cristatus*. *Festuca* species were largely unaffected by fluazifop-P-butyl. Further work on the modification of timing and dose of the graminicide may allow control of weed grasses while minimising adverse effects on desirable perennial grass species. Overall diversity in 1992 and sown perennial species diversity in 1993 were significantly enhanced in plots mown at least twice, results also demonstrated by Smith & Macdonald (1992). This effect was almost certainly mediated by the suppression of sown annual species.

In previous work (Marshall & Nowakowski, 1992), sown perennial dicotyledonous

species have responded positively to applications of fluazifop-P-butyl and the removal of weed grasses. In this experiment, there was greater competition from the annual dicotyledonous species and no obvious response to fluazifop-P-butyl alone. Mowing at leat twice after application of fluazifop-P-butyl produced greater diversity by reducing cover of these dicotyledonous annuals. It might therefore be argued that mowing could be used instead of a herbicide. This cannot be verified from the work described here, as comparisons between varied cutting treatments with and without a herbicide are needed. Under highly fertile conditions, as in this site, annuals should either not be sown or used at low rates. Nevertheless, the weed seed bank at the edges of fields is often large, capable of producing similarly competitive vegetation.

A feature of the data was the dominance of annual species through the second year on plots treated with fluazifop-P-butyl and not mown. Classical studies of secondary succession (e.g. Bard, 1952) predict the initial dominance by annuals, followed by rapid change to a biennial and perennial flora. This work shows that annual species may continue to dominate the flora under conditions of rapid growth, high canopy development, followed by lodging and shading-out of smaller plants. These conditions, which are most likely a reflection of high soil fertility common to much farmland, will not allow perennials dicotyledonous species to establish easily, delaying succession. This emphasises the importance of refining appropriate management and essential weed control to achieve the aim of rapid establishment of strips of perennial grass and wild flowers in field margins.

ACKNOWLEDGEMENTS

This work was supported by Willmot Pertwee Limited and by the UK Ministry of Agriculture, Fisheries and Food (Project BD0404). The site was kindly provided by Mr and Mrs Hitchin and the chemical by Zeneca plc.

REFERENCES

Bard, G.E. (1952) Secondary succession on the Piedmont of New Jersey. *Ecological Monographs*, **22**, 195-215.

Marshall, E.J.P. (1989) Distribution patterns of plants associated with arable field edges. *Journal of Applied Ecology*, **26**, 247-257.

Marshall, E.J.P. (1993) Exploiting semi-natural habitats as part of good agricultural practice. In: *Scientific basis for codes of good agricultural practice.* V.W.L. Jordan (Ed.) EUR 14957. Commission of the European Communities, Luxembourg. pp. 95-100

Marshall, E.J.P.; Nowakowski, M. (1992) Herbicide and cutting treatments for establishment and management of diverse field margin strips. *Aspects of Applied Biology* **29**, *Vegetation management in forestry, amenity and conservation areas.* pp 425-430.

Smith, H. & Macdonald, D.W. (1992) The impacts of mowing and sowing on weed populations and species richness in field margin set-aside. *British Crop Protection Council Monograph No. 50, Set-Aside*, Thornton Heath: BCPC Publications, pp. 117-122.

Thomas, M.B.; Wratten, S.D.; Sotherton, N.W. (1992) Creation of 'island' habitats in farmland to manipulate populations of beneficial arthropods: predator densities and emigration. *Journal of Applied Ecology*, **28**, 906-917.